CLAIMS

1. A method for in situ remediation of an aquifer having a treatment zone through which passes water contaminated with at least one chemical contaminant which method comprises:

a) delivering to the treatment zone a microbial culture capable of degrading at least one chemical contaminant present in said aquifer; and

b) injecting, by at least two conduits, an oxygen-containing gas at a pressure of at least 5 psig above the hydrostatic pressure at injection points with injection frequency and volume at each injection point having the relationship according to the following equation:

$$e^{[(-V \times F \times N \times H)/(W \times B \times Q)]} > 0.50$$

Wherein:

e = natural exponential

V = volume of gas injected at each injection point (ft3)

F = frequency of injections (number of injections per day)

N = number of gas injection points

W = width of the treatment zone perpendicular to groundwater flow path (ft)

B = vertical thickness of treatment zone (ft)

Q = specific discharge of ~~treatment~~ zone to the groundwater treatment zone (ft/day)

H = Henry's Constant for contaminant of interest ((mg/L-water)/(mg/L-air))

2. The method of claim 1, wherein, wherein $e^{[(-V \times F \times N \times H)/(W \times B \times Q)]}$ is greater than 0.80.

3. The method according to claim 1, wherein said contaminant is an oxygenate chemical; wherein $e^{[(-V \times F \times N \times H)/(W \times B \times Q)]}$ is greater than 0.90 and the contaminant loss from volatilization is less than 10% by weight.

4. The method according to claim 1, wherein the contaminant is selected from the group consisting of (a) methyl-t-butyl ether (MTBE), (b) t-butyl alcohol (TBA), and (c) a mixture thereof; wherein at least a portion of the contaminant is degraded to carbon dioxide by said microbial culture.

5. A method for in situ remediation of an aquifer having a treatment zone through which passes water contaminated with at least one chemical contaminant which method comprises:

a) injecting, by at least two conduits, an oxygen-containing gas at a pressure of at least 5 psig above the hydrostatic pressure at injection points;

and

b) delivering to the treatment zone a microbial culture capable of degrading at least one chemical contaminant; wherein, the loss of contaminant(s) from volatilization is less than 50% by weight.

6. A method for in situ remediation of an aquifer having a treatment zone through which passes water contaminated with at least one chemical contaminant which method comprises:

a) injecting, by at least two conduits, an oxygen-containing gas at a pressure of at least 5 psig above the hydrostatic pressure at injection points at a frequency of from about once a week to about ten times a day; and

b) delivering to the treatment zone a microbial culture capable of degrading at least one chemical contaminant.

7. The method according to claim 5, wherein said contaminant is selected from the group consisting of (a) methyl-t-butyl ether (MTBE), (b) t-butyl alcohol (TBA), and (c) a mixture thereof; wherein at least a portion of the contaminant is degraded to carbon dioxide by said microbial culture.

8. The method according to claim 1, wherein the dissolved oxygen concentration in the treatment zone is greater than 2 mg/L.

9. The method according to claim 1, wherein the dissolved oxygen concentration in the treatment zone is greater than 8 mg/L.

10. The method according to claim 1, wherein the dissolved oxygen concentration in the treatment zone is greater than 18 mg/L.

11. The method according to claim 6, wherein the volume of oxygen-containing gas injected each time at each injection point contains from about 1 to about 100 times

of minimum average volume (Vmin) in cubic feet of total oxygen, measured at ambient temperature and ambient pressure, Wherein Vmin can be calculated as:

$$V\ min = 0.1 \times A \times B \times P \div N$$

Wherein A = treated area (square ft)

B = treatment thickness (ft)

P = porosity

N = number of injection points

12. The method according to claim 1, wherein said bacterial culture is delivered to the treatment zone by a network of a plurality of delivery conduits at a pressure of at least 10 psig greater than the hydrostatic head pressure at point(s) of injection.

13. The method according to claim 1, the oxygen-containing gas is injected to the aquifer by at least two gas injectors having respective perforated sections located at at least two different depths within the aquifer.

14. The method according to claim 6, wherein the oxygen-containing gas is injected to the aquifer by a plurality of gas injectors spaced less than 10 ft apart.

15. The method according to claim 5, wherein each injection of oxygen-containing gas at each injection point lasts from about 0.05 to about 4 minutes.

16. The method according to claim 6, wherein each injection of oxygen-containing gas at each injection point lasts from about 0.05 to about 4 minutes.

17. The method according to claim 1, which method further comprises storing the oxygen-containing gas in at least one gas storage tank and subsequently delivering the oxygen-containing gas to at least one sub-surface injection point by intermittent pulsed injection; and maintaining relatively uniform aerobic conditions in the treatment zone by adjusting the volume per injection and the injection frequency, and by monitoring the oxygen flow from each gas storage tank to each sub-surface gas injection point using at least one pressure gauge and/or gas flow meter, monitoring dissolved oxygen concentration in the treatment zone using ground water monitoring points and dissolved oxygen sensors, and adjusting the frequency and volume of each injection of oxygen-containing gas using a controller associated with said monitoring equipment.

18. The method as claimed in claim 17, which method further comprises storing the oxygen-containing gas in at least two gas storage tanks, each storage tank being connected to at least one sub-surface injection point.

19. The method as claimed in claim 1, wherein said microbial culture and said oxygen-containing gas is delivered through the same conduit(s) to the treatment zone.

20. A method for in situ remediation of oxygenate chemical(s) in an aquifer having a treatment zone through which passes water contaminated with oxygenate chemicals, which method comprises:

a) delivering to the treatment zone a microbial culture capable of degrading at least one oxygenate chemical contaminant; and

b) injecting, by at least two conduits, an oxygen-containing gas at a pressure of at least 5 psig above the hydrostatic pressure at injection points with injection frequency and volume at each injection point having the relationship according to the following equation:

$$e^{[(-V \times F \times N \times H)/(W \times B \times Q)]} > 0.90$$

Wherein:

e = natural exponential

V = volume of gas injected at each injection point (ft3)

F = frequency of injections (number of injections per day)

N = number of gas injection points

W = width of treatment zone perpendicular to groundwater flow path (ft)

B = vertical thickness of treatment zone (ft)

Q = specific discharge of groundwater to treatment zone (ft/day)

H = Henry's Constant for contaminant of interest ((mg/L-water)/(mg/L-air))

Wherein the loss of contaminant from volatilization and/or dispersion is less than 10% by weight; wherein the oxygen-containing gas is injected to the aquifer by at least two gas injectors having respective perforated sections located at least two different depths within the aquifer; wherein the oxygen-containing gas is injected to the aquifer by a plurality of gas injectors spaced less than 10 ft apart; wherein each injection of oxygen-

containing gas at each injection point lasts from about 0.05 to about 4 minutes.